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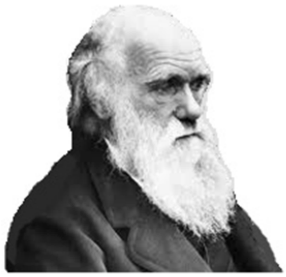

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Study of cropping system characterization, seed production and storage practices of rice (*Oryza sativa* L.) in Lamjung, Nepal

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ABSTRACT

This study was carried out in Harrabot village of Tarkughat VDC, Paundi and Majuwa village of Sundarbazar Municipality of Lamjung district during 2015/2016. Thirty households (10 HH from each village) who were involved in seed production were purposively selected for survey. The respondents' knowledge was gathered through the focus group discussions and household surveys, using a pretested semi-structured questionnaire. Seed routine test was carried out in the Agronomy lab of Lamjung Campus. Results revealed that the dominant features of farming in the study areas were small land holdings, fragmented and sloping land with rainfall-dependent farming. Land distribution pattern was 12.93% marginal land, 16.35% upland, and 70.72% irrigated lowland. Farmers grew rice, maize, mustard and pulses as major crops and fruits, vegetables, potato and flowers as minor crops. Major cropping patterns were Rice-Mustard-Maize, Maize-Rice-Fallow, Rice-Fallow-Rice, etc. Nutrient-poor soils, low pH, farmers' poor access to inorganic fertilizers, soil-depleting cropping patterns, lack of technical knowledge on crop management, soil erosion and degradation are major challenges. Insects, diseases, and weeds were major biotic constraints, while lack of irrigation, drought and lack of technical support were major abiotic constraints of rice production. Sukhadhan-2, Sukhadhan-3, Sukhadhan-4, Sukhadhan-5 and Sukhadhan-6 were planted in rain-fed lowland, whereas Ramdhan, Sunaulo sugandha, Loktantra, Sabitri, and Makwanpur-1 were grown in irrigated lowland. Seed producers used 39.07% of the land for seed production with 4.78 $t{\cdot}ha^{-1}$ of seed productivity. Most of their produced seed was send to Sundar Seed Coop Ltd., Paudibazar, while some seed were stored in their home by using local containers, such as earthen pots, plastic drums, metal bins, Dali, Kotho, Bhakari, etc. The tested seed

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quality parameter in the lab showed that the average moisture, purity, and germination percentage of the seed samples were 13.87%, 94.13% and 96.72%, respectively.

***Keywords*:** Drought, germination, Cropping pattern, post harvest practice, varieties, *Oryza sativa*

1. INTRODUCTION

Rice (*Oryza sativa*) is considered as an important staple food crops for most of the people in the world. South Asian continent, especially Nepal is considered as the origin center of rice [1]. It contributes 6.93% to GDP and 20.75% to AGDP in Nepal [2]. Of the 75 districts, rice is grown in 73 districts, except Mustang and Manang of trans-Himalayan region [3]. Rice is grown from the lowest elevation (60 m asl) at Kechanakalan Jhapa to the highest elevation (3050 m asl –above sea level) in the world (Chhumchoure, in Jumla district) [4]. Out of 74 rice varieties grown in Nepal, 57 are released and 17 are registered varieties [5] in Nepal. Rice occupies 45.96% of the total agricultural land cultivated.

The production of rice is 4788612 MT in an area of 1425346 ha of land with productivity of 3.36 $t \cdot ha^{-1}$ in Nepal in fiscal year 2017/072BS [6]. While in Lamjung the production of rice is 42115 Mt in 16153 ha area of land with productivity of 2.6 $t \cdot ha^{-1}$ [2]. The recommended popular varieties of rice used in Lamjung are Sukhadhan-1, Sukhadhan-2, Sukhadhan-3, Sukhadhan-4, Sukhadhan-5, Sukhadhan-6, Hardinath-1, Hardinath-2, Makwanpur-1, Sabitri, Sunaulo sugandha, Loktantra, etc. as inbred improved varieties and US-312, Prithibi, Chandani, US 257 as hybrid rice varieties. The popular traditional varieties/landraces available in Lamjung are Aanga, Manavog, Biramphul, Aanadi, Eakle, Dalle, Masino, etc. The area, production and yield of rice in 1968/69 was 1162000 (ha), 2178000 (t), and 1874 $t \cdot ha^{-1}$ which has increased to 1555940 (ha), 4523693 (t) and 2,907 kg/ha in 2008/2009, respectively. Thus it shows an increment of about 34% in area, 108% in production, and 55% productivity in 2008/09 over 1968/69 [7].

Among the different factors for the rice production, availability of quality seed is a basic factor for rice production. The use of high quality seeds enhances the production efficiency in any of the farming system [8]. The dominant features of the farming in the study areas are small land holdings, sloping marginal land and rainfall-dependent farming. The general cropping system in Lamjung district in Khetland is Maize – Rice – Fallow, or Rice – Wheat – Fallow. Rice – Potato – Maize, etc. In upland condition, Maize – Fingermillet, Maize – Pules crops (Soybean, cowpea, blackgram, etc. as sole crop or intercropped pulses with maize or mustards) intercrop with Wheat crop [9]. Cropping system characterization helps to know the climatic suitability of the area for any of the crop production (especially rice being focused). Cropping system characterization also included soil characteristics of the specific location, rice varieties being cultivated, pedigree of the seed used, type of land used for rice seed production, information on crop cultivation year round and major constraints faced during the seed production.

Seed production and storage requires a scientific knowledge, but people are ignorant and do not care for the purity of the seed and mix all varieties of rice seed, they grow and store at a common bag or other container. On the local level, most of the seed produced by groups is sold to other farmers informally in their community without labeling which is the major problem to affect the purity. The traditional storage containers are not in proper condition so that the required level of moisture cannot be maintained which may convey the loss of viability of seed and alter the germination percentage of the seed. Nutrient-poor soils, low pH, poor access to inorganic fertilizers, soil-depleting cropping patterns, lack of technical knowledge on crop management are the major challenges [10]. In addition to these problems, the recommended technologies are not suitable for all agri-ecological domains from Terai to high hills in Nepal. People with their indigenous technical knowledge are engaged in the rice seed production maintaining the purity with the field standards and in the storage practices. This study was conducted to characterize the cropping system, seed production, and storage practices of rice in Harrabot village of Tarkughat VDC, Paundi and Majhuwa villages of Sundarbazar Municipality in Lamung district, Nepal.

2. MATERIALS AND METHODS

The study was conducted in Harrabot village of Targhughat VDC, Majuwa and Paudi villages of Sundarbazar Municipality during 2015. These villages are present around 600 to 800 m asl which represent mid-hill parts of Nepal. Study was carried out under the house-hold survey where a total of 30 HH were selected purposively to those farmers who were participated in the active seed production programme (a total of 10 farmers from each three villages). Face-to-face interview was carried out using pre-tested semi-structured questionnaire. A number of agricultural institutions, like IRRI-CURE project, IRRI-STRASA project, IAAS Lamjung campus, Sundar Seed Cooperatives Ltd. Paundi, Lamjung were also included to get primary and the secondary information sources. In addition to these, several literature and journals were also used as the sources of secondary information. The cropping system characterization, varieties used, seed production and storage practices and other managemental problems were focused on the study. Seed samples were collected from the individual households (HHs) in order to identify the quality parameters of the seed stored under the farmers practice. Focal group discussion (FGD) was also carried out to get effective information from each village. After the completion of survey during November-December, 2015, the laboratory works for the determination of seed quality were carried out during February, 2016, in Lamjung campus. The seed samples were taken from Sukhadhan 2, Sukhadhan 3, Sukhadhan 4, Sukhadhan 5, Sukhadhan 6, Sunaulo sugandha, Sabitri, Ramdhan, Makawanpur-1, and Loktantra varieties of rice. Germination test was carried out using peridish method under favourable condition at room temperature. For purity determination, seed purity board was used in the lab. Similarly, moisture was taken using portable electronic grain moisture meter.

3. RESULTS AND DISCUSSION

3. 1. General Household characteristics

The study result showed that the population which is actively involved in rice seed production was at the age group of 41-50 years, accounting 43.3% and the remaining population were engaged in country and abroad services. Regarding the gender study, a total of 56.7% of male and 43.3% of female farmers were involved in the seed production. Brahmin and Chhetri, which are seen as the upper caste Hindus, were dominating caste in the study area, contributing

83.3% of total households. There were 20 families in the study area with the household population ranging from 4-6 members in size (66.7%).

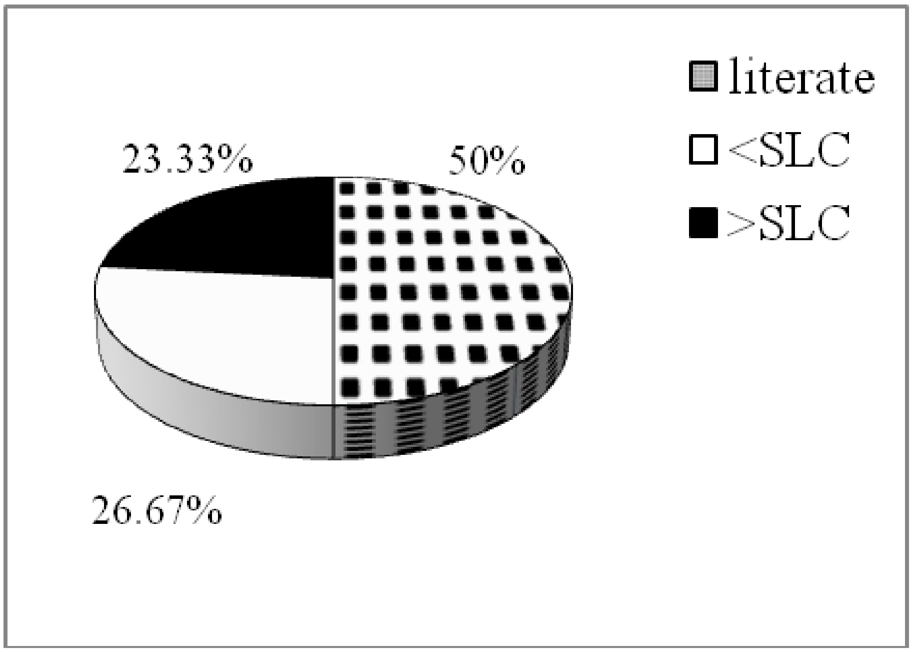

Fig. 1. Education level of the farmer involved in seed production program

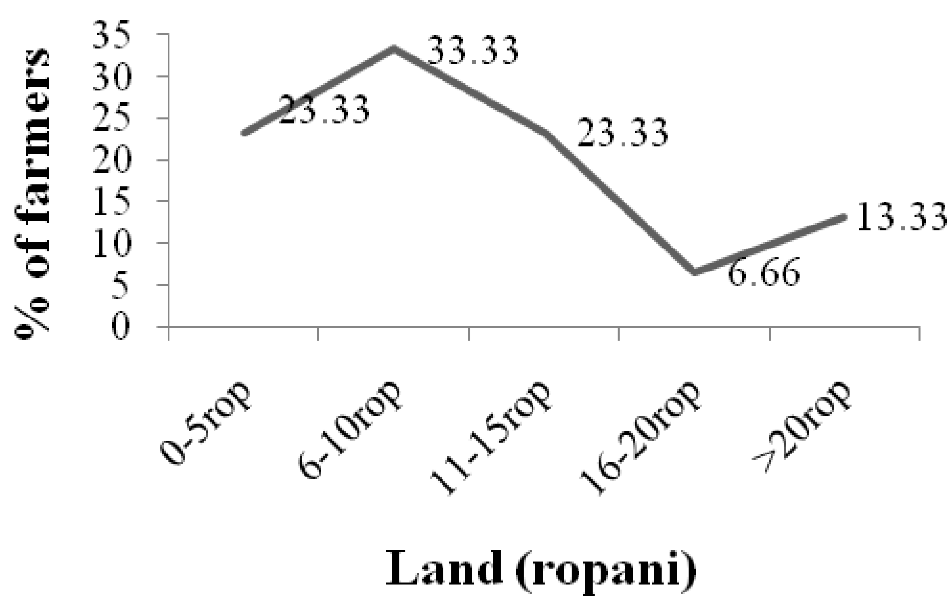

Fig. 2. Land holdings of farmer in the research areas

Regarding the educational status of farmers, a total of 50% farmers were literate, 26.67% were got below SLC degree, and 23.33% got above SLC degree (**Fig. 1**). Land holding showed that a total of 33.3% of the farmers have land holding 6-10 Ropani, 23.33% people have less than 0.5 Ropani and 11-15 Ropani, 6.66% have 16-20 Ropani, and 13.33% have more than 20 Ropani (>1ha) (**Fig. 2**). A total of 10% of the farmers are producing the rice seed by taking the land in lease (*rented in*).

3. 2. Major features of the cropping system

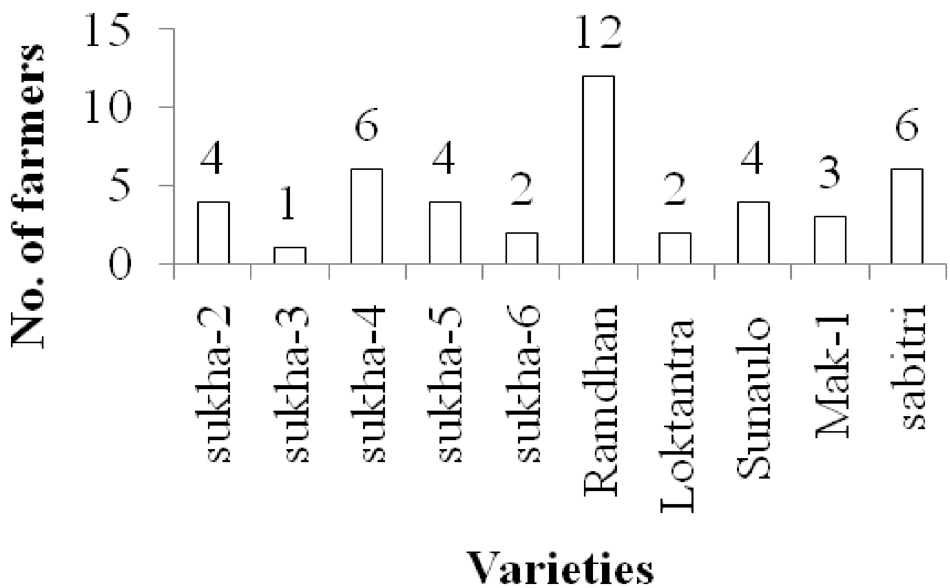

Fig. 3. Preference of farmers to the rice seed varieties

Small land holding of the farmers, fragmented land holding, rainfall dependent farming were major characters of farming system. Rice, maize, mustard, potato and pulses are grown as the major crops where fruits, vegetables, and flowers are the minor crops. The major cropping systems followed were: Rice – maize – fallow, Rice – mustard –maize, Rice –fallow –rice in lowland, where as in case of upland the major cropping patterns were: Maize – fingermiller – fallow, Maize – blackgram – fallow, Maize – Soybean – fallow, Maize – mustard – fallow, Rice –vegetable –maize, etc. Insects, rodents, diseases, and weeds are the major biotic constraints while lack of irrigation, drought, and lack of technical support were the major abiotic constraints for rice production. Sukhadhan-2, Sukhadhan-3, Sukhadhan-4, Sukhadhan-5, Sukhadhan-6 and Radha-4 planted in rainfed lowland, whereas Ramdhan, Sunaulo sugandha, Sabitri, Loktantra, and Makwanpur-1 planted in irrigated lowland. DADO Lamjung, IRRI-STRATA and CURE project, Sundar Seed Cooperative Ltd. were working with the farmers for as-source of resources and for technology dissemination. Most of the seed produced by farmers in different villages were sent to Sundar Seed Cooperative, Paudibazar, while some seeds were stored in local seed containers, such as earthen pot, plastic drum, metal bins, dali and Bhakari (made up of bamboo) for home use.

Regarding the variety of use, the Ramdhan was the best variety followed by Sabitri being selected in irrigated areas by many farmers in the study sites for seed production (**Fig. 3**). The best preference of Ramdhan was due to its good taste, fineness, short growing period, good production potentiality (4.0-7.2 $t \cdot ha^{-1}$) [11]. In the rainfed lowland, the Sukhadhan growing farmers were higher as compared to other drought tolerant rice varieties. The preference of these varieties might be due to the high production potentiality, high drought tolerant capacity, disease resistance, early maturity, etc.

3. 3. Land used by the farmers

Results revealed that in the study area, most of the land, was lowland (70.7%), while only 16.4% was upland and the remaining 12.9% was marginal land. Farmers used 39.1% of their cultivable land in rice seed production while rest of the land (60.9%) was used for grain production.

3. 4. Seed productivity

The productivity of the rice seed in the study area was found quite better (4.77 $t \cdot ha^{-1}$) as compared to the national rice productivity (3.39 $t \cdot ha^{-1}$) (**Fig. 4**). It might be due to the climatic suitability of Lamjung in rice seed production but still the productivity should lie in the range of 5-8 $t \cdot ha^{-1}$.

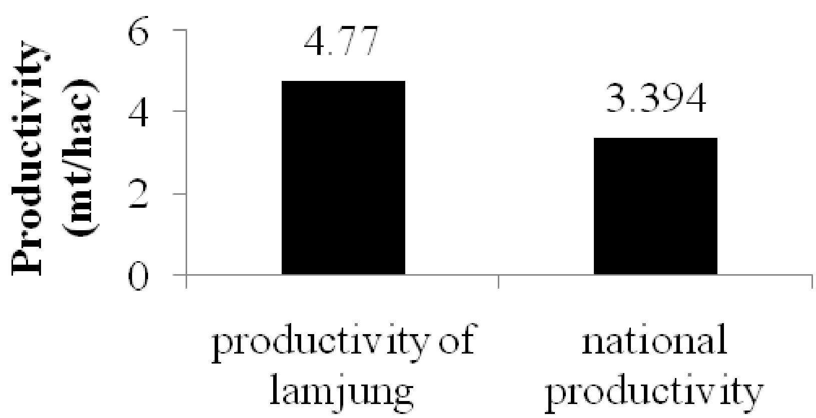

Fig. 4. Comparison of productivity of rice seed in Lamjung with National productivity (SEAN, 2013/14)

3. 5. Study of seed quality parameters

Regarding the seed germination, the Sukhadhan series had higher germination percentage (80-94%) as compared to the other varieties (Loktantra, Makwanpur-1, Ramdhan, Sabitri) at the same environment. Among the Sukhadhan series, the Sukhadhan-2 and Sukhadhan-5 had better germination percentage, i.e. 92.35% and 91.1%, respectively (**Fig. 5**). The average germination percentage of seed was 96.72% which was above the standard germination percentage (>80%) set by the seed quality control center [12].

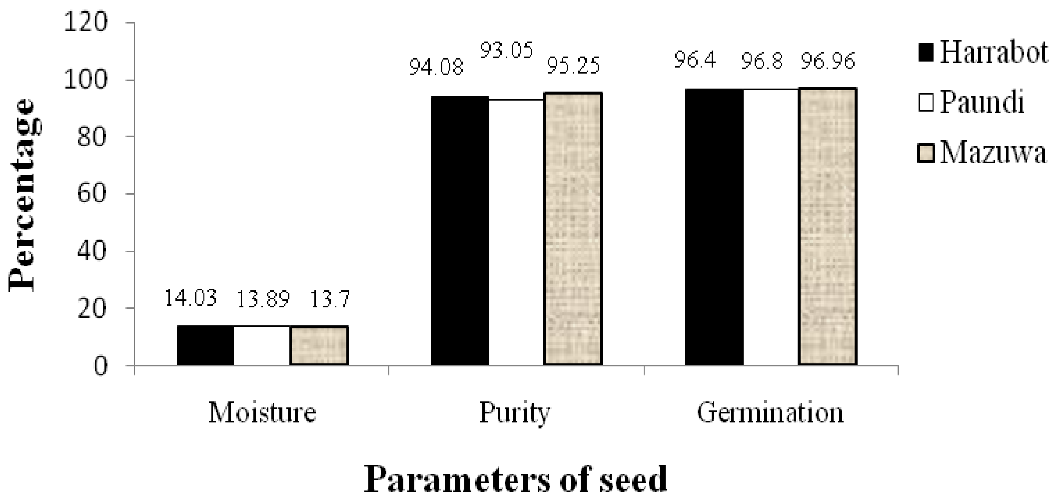

Fig. 5. Quality parameters of seed stored under farmers' practice

3. 6. Seed production and Storage

Farmers get the source seed (foundation seed) from Sundar Seed Coop, Paundibazar, which was obtained from National Rice Research Program, Hardinath, Dhanusha. General seed producer farmers grow their crop using their skill and knowledge developed from seed farmers trainings. Selection of field, maintenance of isolation distance, roughing, control of pest, seed routine test, etc., were quality control mechanisms adopted. Regarding the storage facility, farmers have been using their local seed storage devices, like Bhakari, sacks, Dali, Kothi, earthen pots, metal bins, etc. The seeds selling for Sundar Seed Coop were put in the plastic bags obtained from Sundar Seed Cooperative for a short period of time in their home.

3. 7. Technical Knowhow of the farmers

All the farmers producing seed in different villages were well trained about the seed production technologies, like seed selection according to land type, climatic suitability, seed bed preparation, seed rate, weeding, roughing, etc., through IRRI-IFAD-TAG 706, STRASA and CURE project, DADO Lamjung and from Sundar Seed Coop Paudibazar Lamjung. It is found that farmers were got training 2-3 times each year on the quality seed production technologies from these institutions.

3. 8. Institutional supports

Farmers reported that they have been getting 25% seed subsidy on source seed from IRRI project, and in some years 50% subsidy from DADO, Lamjung. The subsidy on transportation of source is provided by DADO Lamjung if seed is collected through DADO program. DADO, IAAS CURE/STRASA project conducted frequent trainings, exposure visit and monitored the different seed activities of seed producer farmers periodically. The field technicians from the DADO and rice experts from IAAS frequently inspected the rice seed plots of the farmers. Farmers were inspired to conduct different seed activities in their farm from the kind cooperation of DADO people and IAAS/IRRI projects.

3. 9. Major problems faced during seed production and storage

Because of sloppy and undulated land with small terraces, most of the seed activities from seeding to harvesting and processing is done manually. It is very costly. So that the seed produced in hill peoples is very costly and cannot compete with the product from plant areas like Chitwan, Bhairahawa, etc. The major problem was, that all the produced seed was not collected by the Sundar Seed Cooperative in time which is the regular reliable market for the farmers. The major insects in the field were Stem borer, Grass hopper, Rice Gundhi Bug, Leaf hopper, Leaf roller, and Rice hispa which have infestation in some times under favourable condition. Diseases like Blast, Blight, Leaf spot disease, False smut, were severe diseases to hurdle the production of farmer in some times. Rodent problem was unavoidable during production and storage, and farmers were in dilemma in order to store or to provide all seeds to the Cooperative immediately after harvest and processing (Winnowing, Cleaning, Drying, and Packing). Storage pest, like *Sitophilus* sp., Grain moth, were severe to degrade the seed quality. In order to manage, the pest farmers used Neem leaf (*Azadirachta indica*), Titepati (*Artimisia vulgaris*) mixing the grinded leaf in the rice seed as bio-pesticide. Other associated problems were the water scarcity during the time of seedling transplantation and during panicle initiation, scarcity of the quality source seed, fertilizers and pesticides, etc. The germination percentage of the improved seed was also the problem in some years.

3. 10. Farmers experience with the climate change

The irrelevance of rain and sunlight has greatly altered the production of the rice seed. In case of Lamjung, the main problem was the drought during transplanting of seedling and panicle initiation, and there was a massive rainfall during harvesting of rice. Temperature fluctuations had created the sterility in seed. High temperature and long drought during and right before the flowering phase may lead to a complete sterility [13], while high temperature during vegetative and ripening phases alters the grainfilling, and thus, the grain quality of the rice [14]. No strong storm and hailstone were recorded in the present years during the rice plantation season. The transplantation was delayed up to Bhadra due to a long drought during transplanting. So most of the farmers in such condition used the old aged seedling (up to 40-60 days and the seedling per hill was about 8-10 in number but in normal condition 20-25 days old seedling were used and the seedling per hill was 2-3 in general). The maximum temperature in Nepal has increased by 1.8 °C over the period of 1975 to 2006, and precipitation has become more erratic [15-18]. During 1977 and 1994, the Terai region has, on average, seen an increase in annual temperature of 0.04 °C/year.

4. CONCLUSIONS

In the study area, 43% of female populations were engaged in seed production program of which Brahmin (40%), Chhetri (43%), Janajati (13%), and Dalit (4%). It was also found that 66.67% of the actively participating farmers had family size of four-six members. Farmers of age group 41-50 were actively participating in the seed production program, of which 50% were literate only. Most of the farmers had 6-10 ropani of land as sloping-marginal (12.93%), upland (16.35%), and lowland (70.72%). Farmers selected Sukhadhan series (from 2-6) as drought tolerant variety and other preferred varieties were Ramdhan, Sunaulo sugandha, Loktantra and

Makwanpur-1. Ramdhan was most preferred and grown by 40% farmers. Land selected for seed production was 39.07% and the productivity was 4.78 tons per ha.

Major cropping patterns were rice-mustard-maize, maize-rice-fallow, rice-fallow-rice, etc. DADO Lamjung, IRRI-STRASA, CURE, Sundar Seed Coop, were directly working with the farmers to produce, deliver of the quality seed to the farmers. Lack of quality seed, insect pest, and diseases were major biotic constraints while lack of irrigation, drought, and lack of technical support were the major abiotic constraints of rice production. Quality seed production became source of livelihood and had weightage in reduction of poverty.

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